

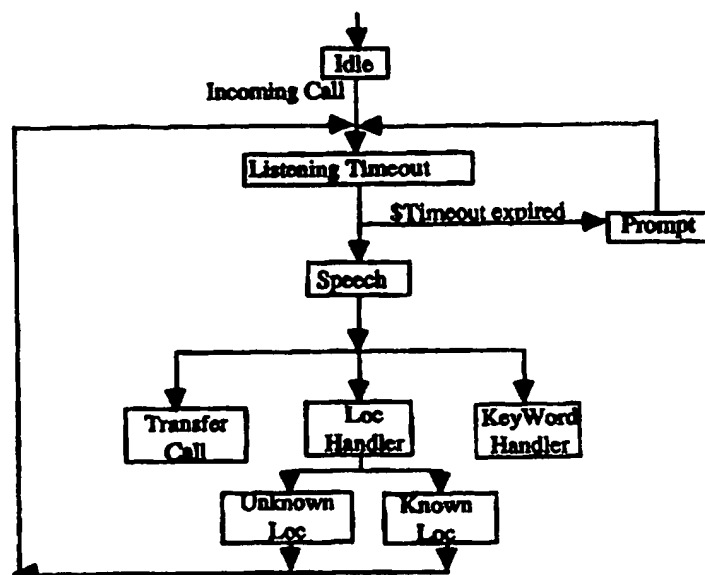


PCT

WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification ⁶ : H04M 1/27, G10L 5/06	A1	(11) International Publication Number: WO 97/37481 (43) International Publication Date: 9 October 1997 (09.10.97)
(21) International Application Number: PCT/CA97/00008 (22) International Filing Date: 9 January 1997 (09.01.97) (30) Priority Data: 08/623,635 28 March 1996 (28.03.96) US (71) Applicant: NORTHERN TELECOM LIMITED [CA/CA]; World Trade Center of Montreal, 8th floor, 380 St. Antoine Street West, Montreal, Quebec H2Y 3Y4 (CA). (72) Inventor: WONG, Chi; Apartment #3390, 2850 Middlefield Road, Palo Alto, CA 94306 (US). (74) Agent: MacGREGOR, George; Northern Telecom Limited, Patent Dept., P.O. Box 3511, Station "C", Ottawa, Ontario K1Y 4H7 (CA).		(81) Designated States: CA, European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE). Published <i>With international search report.</i>
(54) Title: APPARATUS AND METHOD FOR REDUCING SPEECH RECOGNITION VOCABULARY PERPLEXITY AND DYNAMICALLY SELECTING ACOUSTIC MODELS		



(57) Abstract

A method of reducing the perplexity of a speech recognition vocabulary and dynamically selecting speech recognition acoustic model sets used in a simulated telephone operator apparatus. The directory of users of the telephone network is subdivided into subsets wherein each subset contains the names of users within a certain location or exchange. A speech recognition vocabulary database is compiled for each subset and the appropriate database is loaded into the speech recognition apparatus in response to a requested call to the location covered by the subset. Furthermore, a site-specific acoustic model set is dynamically loaded according to the location of a calling party. An apparatus for carrying out the method is also discussed.

FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AL	Albania	ES	Spain	LS	Lesotho	SI	Slovenia
AM	Armenia	FI	Finland	LT	Lithuania	SK	Slovakia
AT	Austria	FR	France	LU	Luxembourg	SN	Senegal
AU	Australia	GA	Gabon	LV	Latvia	SZ	Swaziland
AZ	Azerbaijan	GB	United Kingdom	MC	Monaco	TD	Chad
BA	Bosnia and Herzegovina	GE	Georgia	MD	Republic of Moldova	TG	Togo
BB	Barbados	GH	Ghana	MG	Madagascar	TJ	Tajikistan
BE	Belgium	GN	Guinea	MK	The former Yugoslav Republic of Macedonia	TM	Turkmenistan
BF	Burkina Faso	GR	Greece	ML	Mali	TR	Turkey
BG	Bulgaria	HU	Hungary	MN	Mongolia	TT	Trinidad and Tobago
BJ	Benin	IE	Ireland	MR	Mauritania	UA	Ukraine
BR	Brazil	IL	Israel	MW	Malawi	UG	Uganda
BY	Belarus	IS	Iceland	MX	Mexico	US	United States of America
CA	Canada	IT	Italy	NE	Niger	UZ	Uzbekistan
CF	Central African Republic	JP	Japan	NL	Netherlands	VN	Viet Nam
CG	Congo	KE	Kenya	NO	Norway	YU	Yugoslavia
CH	Switzerland	KG	Kyrgyzstan	NZ	New Zealand	ZW	Zimbabwe
CI	Côte d'Ivoire	KP	Democratic People's Republic of Korea	PL	Poland		
CM	Cameroon	KR	Republic of Korea	PT	Portugal		
CN	China	KZ	Kazakhstan	RO	Romania		
CU	Cuba	LC	Saint Lucia	RU	Russian Federation		
CZ	Czech Republic	LI	Liechtenstein	SD	Sudan		
DE	Germany	LK	Sri Lanka	SE	Sweden		
DK	Denmark	LR	Liberia	SG	Singapore		
EE	Estonia						

APPARATUS AND METHOD FOR REDUCING SPEECH RECOGNITION
VOCABULARY PERPLEXITY AND DYNAMICALLY SELECTING
ACOUSTIC MODELS

5

Field of the Invention

This invention relates to automatic speech
recognition in telecommunication systems and to the use of
such systems to provide large scale voice activated dialing
10 and information retrieval services.

Background to the Invention

In the early development of telephone systems it
was commonplace for a telephone subscriber to converse
15 directly with a telephone operator at a telephone central
office. The telephone subscriber would verbally request the
telephone operator to complete a connection to a called
party. As telephone exchanges were small the telephone
operator was aware of virtually all of the subscribers by
20 name and manually completed the requested connection. With
the advent of dial telephone services, calls within an
exchange could be completed automatically, and only certain
toll calls required operator assistance. Today, operator
assisted calls have become the exception and are usually
25 comparatively expensive. Machine-simulated operator
functions, including limited speech recognition services,
have recently been available for expediting some typical
operator-assisted functions. This includes "collect" long
distance calls wherein completion of the connection is
30 contingent upon the called party agreeing to pay for the
service. However, these functions are limited to the simple
recognition of "yes" or "no" so there is little room for
non-functionality due to uncertainty as to which word was
spoken. There have also been advancements in voice
35 recognition services relating to directory assistance but
these too are directed to a very limited vocabulary.

Prior Art

The prior art contains several recent developments pertaining to voice recognition in general, and to voice recognition applicable to telecommunication systems in particular.

U.S. Patent No. 5,091,947, which issued February 25, 1992 to Ariyoshi et al, entitled "Speech Recognition Method and Apparatus", discloses a voice recognition system for comparing both speaker dependent and speaker independent utterances against stored voice patterns within a coefficient memory. The voice identification comparator selects the one voice pattern having the highest degree of similarity with the utterance in question.

15

In U.S. Patent No. 5,165,095, which issued on November 17, 1992, Borchherding discloses a voice recognition system to initiate dialog to determine the correct telephone number. According to the '095 patent, the calling party is first identified so that a database containing speaker templates can be accessed. These templates are then used to compare the dial command so that the dialing instructions can be recognized and executed. An example of a dialing directive in the patent is "call home", with "call" being the dial command and "home" being the destination identifier.

Gupta et al, in U.S. Patent No. 5,390,278 issued February 14, 1995, disclose a flexible vocabulary speech recognition for recognizing speech transmitted via the public switched telephone network. This voice recognition technique is a phoneme based system wherein the phonemes are modeled as hidden Markov models.

In spite of these ongoing developments, the functionality of automatic recognition of human speech by machine has not advanced to a degree wherein a calling party

can simply speak the called party's name and thereafter be connected as reliably as a human operator in situations where the database for a potential called party is very large (greater than 100 names).

5

Summary of the Invention

The present invention is in the field of human speech recognition performed by machines and more particularly relates to a reduction of the perplexity of the speech recognition task in the context of names spoken by a telephone user in a telephone system.

Individual users of telephone networks are divided into subsets to facilitate identification of the vast number of subscribers to the service. In the public network these subsets are local exchanges. Private switching networks such as the Nortel Electronic Switching Network (ESN) assigns individual ESN numbers to each location within the private network. The present invention relies on these subsets or location identifiers to reduce the perplexity of a speech recognition application.

Therefore in accordance with a first aspect of the present invention, there is provided a telephone network including a plurality of telephone exchanges, each for serving a plurality of telephone terminals and each being interconnected with at least one other of the telephone exchanges for providing telephone communications between users of the telephone terminals. The network function includes a simulated telephone operator apparatus for receiving a speech request from a user for connection to another telephone user and to translate this request into a directory number for use by the appropriate one of the telephone exchanges. The translation is in accordance with a speech recognition algorithm and an active speech recognition vocabulary selected in accordance with the origin of the request.

In an ESN application the active speech recognition vocabulary is limited to the names of the individuals serviced by the ESN number. In a preferred embodiment the ESN number, which is also a location code, is
5 contained in the first two or three digits of the directory number.

In accordance with a second aspect of the invention there is provided a simulated telephone operator
10 server for a telephone network. The server has means for storing voice utterances of a calling party telephone user and means responsive to location information in association with the telephone user for selecting an active speech recognition vocabulary. Speech detection means are provided
15 for processing the stored voice utterance in accordance with a speech recognition algorithm and the active speech recognition vocabulary. Directory lookup means identify a directory listing of a called party corresponding to a result of the processing by the speech detection means. The
20 server also includes means for transmitting the directory listing to a telephone exchange serving the called party.

In accordance with a further aspect of the invention there is provided a telephone exchange comprising:
25 a plurality of ports for serving a plurality of telephone users' telephone instruments via telephone lines; a trunk facility for connection to another telephone exchange; a switching network for connecting and disconnecting the telephone instruments; a controller means for causing a
30 newly OFF HOOK telephone instrument to be coupled via the switching network with a solicitation signal, and subsequently for being responsive to a telephone number received in association with the newly OFF HOOK telephone instrument for completing a telephone call via the switching
35 network. The exchange also includes an originating register means for storing voice band signals received from the newly OFF HOOK telephone instrument via the switching network.

Means are provided for detecting digits represented by frequency signals, within the stored voice band signals, in accordance with a standard for key pad dialed telephone numbers and for transmitting detected digits to the call controller. A simulated telephone operator apparatus receives and translates voice band signals in accordance with a speech recognition algorithm and an active speech recognition vocabulary selected in accordance with the origin of the voice band signals into a directory number for use by the controller means. An interface facility is provided for transmitting the stored voice band signals via the switching network to the simulated telephone operator server apparatus in an event wherein the voice band signals did not include a key pad dialed digit.

15

In accordance with yet a further aspect of the present invention there is provided a method of detecting a voiced speech request of a calling party for connection to another user of an automatic telephone exchange. The method comprises storing a plurality of speech recognition vocabularies in association with geographic location of users; receiving the voiced request and information as to the geographic location of the user having voiced the request from the automatic telephone exchange; selecting an active speech recognition vocabulary in accordance with the information as to the geographic location of the user and, in accordance with a speech recognition algorithm and the selected active speech recognition vocabulary, translating the received request into a directory number for use by the automatic telephone exchange in setting up a telephone connection between the calling telephone user and the other telephone user.

Brief Description of the Drawings

The invention will now be described in greater detail with reference to the attached drawings wherein:

FIGURE 1 is a block diagram illustrating trunk connections between private switch locations;

FIGURE 2 is a block diagram of the system hardware architecture;

5 FIGURE 3 is an overall system state diagram; and

FIGURE 4 is a state diagram of the key word handler.

Detailed Description of the Invention

10 The following description relates to an enterprise-wide speech directory calling service within a company or corporation having a number of locations. Each location is assigned a unique electronic switching network (ESN) location code or ESN number. As shown in the block
15 diagram of FIGURE 1, the on-site PBX 20 at each location is connected to each other location via trunk connectors 22. In this discussion the ESN comprises a three-digit code to identify the location. It is to be understood, however, that it is not essential to use all three digits to identify
20 the location as it may be sufficient to use the first two for example.

FIGURE 2 illustrates the hardware architecture in accordance with a preferred embodiment of the invention. As
25 shown, PBX 20 is connected to trunk 22 and to a plurality of on site telephone sets as known in the art. The speech recognition system 30 of the invention is connected to the PBX 20 via T1 line 32 via T1 card 34 and via signal link 36 and signal link card 38. Speech recognition system 30
30 includes a speech recognition processor operating on a speech recognition algorithm, central processor and control units as well as memory cards for storing active speech recognition vocabulary data bases.

35 Although FIGURE 1 refers to a private switching network using ESNs, it is to be understood that the

invention is not limited to such networks but can also be adapted to use in public switching systems.

One objective metric used to measure the accuracy of a speech recognition system is the Word Error Rate (WER). The WER is defined as the total number of incorrectly recognized words made by a speech recognition system divided by the total number of words spoken by a user of the system.

$$WER = \frac{\text{Number of Errors Made by Recognizer}}{\text{Number of Words Spoken by User}}$$

The present invention makes use of information as to the calling party's location for automatically assisting in improving the WER of a speech recognition system on a spoken called party's name for the purpose of connecting a telephone call.

It has been empirically shown that the WER of a speech recognition system will vary with the square root of the perplexity of the vocabulary of words being recognized. [Kimbal, O., et al., "Recognition Performance and Grammatical Constraints", Proceedings of a Workshop on Speech Recognition, Report Number SAIC-86/1546, Defense Advanced Research Projects Agency, Palo Alto, February 19-20, 1986.]

$$WER \propto \sqrt{\text{Perplexity}}$$

The perplexity of a vocabulary is defined as the measure of the constraint imposed by a grammar, or the level of uncertainty given the grammar of a population of users. Perplexity is mathematically modeled and quantified in the following way:

$$H = -\frac{1}{|V|} \sum_{w \in V} P(w) \cdot \log P(w)$$

$$B = 2^H$$

where: H is entropy
 $P(w)$ is the probability of w being spoken
5 B is the perplexity of the application

The vocabulary of words in this implementation consists entirely of proper names; location names, and a small number of key words for command and control. For
10 large corporations with a large number of employees, the proper names become the determining factor in measuring the perplexity since the number of employees will overwhelm the number of location names and key words. Thus location names and key words can be ignored in this calculation. If we
15 make a simplifying assumption that every name is spoken with equal probability, then the equation above can be simplified to the following:

$$\text{Perplexity} = \sqrt[L]{S}$$

20

where: L is the average number of words in a sentence
 S is the number of sentences in the vocabulary V

If we further make the simplification that proper
25 names contain two words -- first and last name -- and the number of sentences in the vocabulary is equivalent to the number of employee names, then we can further reduce the equation to the following:

$$\text{Perplexity} = \sqrt{S}$$

30

If we make the assumption that the amount of confusability between names within a large database will be similar between large databases, the accuracy of a speech
35 recognition system has the following relationship with the number of names in the vocabulary:

$$WER \propto \sqrt[4]{\text{Number of Active Directory Names}}$$

We can observe from the above equations that the WER increases with the perplexity and thus increases with the number of proper names in the vocabulary.

In the past, speech recognition scientists have used various methods to reduce the perplexity in an effort to improve the WER of a speech recognition system. To achieve this result, most of these efforts have been focused at the linguistic level. For example, scientists have used statistical language models and linguistics rules of phonology to reduce perplexity or uncertainty in recognizing a spoken word or phrase.

15

In this implementation the list of employee names for each location is stored in a separate speech recognition vocabulary. The employee name will normally be associated with the four digits of the telephone number following the three-digit ESN or location code. According to the system of the present invention a calling party wishing to speak to another employee at the same location will simply announce the first and last name of the employee to whom a connection is desired. The speech recognition system will assume that calling party and called party are at the same location and load the active speech recognition vocabulary database containing the names of all employees at that location. Using a conventional speech recognition algorithm the name spoken by the calling party is compared by the system against the names of all employees in the database and the closest match is selected. The name selected is announced to the calling party and the call is automatically connected to the line associated with the telephone number assigned to the called party unless the calling party interrupts the process by saying, "No." Thereafter the voice recognition system releases from the call.

If the called party is at a different location than the calling party, the calling party will first announce the location of the called party followed by the called party's name. The voice recognition system responds
5 by announcing the location and subsequently loading the active voice recognition vocabulary database including the names of all the employees at the announced location of the called party. The voice recognition system then selects the
10 name in the loaded database that most closely matches the name of the called party. The selected name is announced to the calling party and the call is automatically connected to the line associated with the telephone number assigned to the called party unless the calling party interrupts the
15 process by saying, "No." Thereafter the voice recognition system releases from the call.

Because the active voice recognition vocabulary set associated with each ESN or location contains only a portion of the total number of employees of the corporation
20 or company, the WER is much lower than it would be if the complete employee directory was loaded in the database.

The actual decrease in the corporate wide WER (C_WER) is contingent upon how evenly the employees are
25 spread over the different sites. In the best case where the employees are evenly distributed in each site, C_WER will decrease according to the following relation.

$$C_WER = \frac{WER}{\sqrt[4]{n}}$$

30 where: n is the number of sites.

In the worst case, where there is only one employee in each site, except for one site which holds all of the remaining employees, there will be a negligible
35 decrease in the C_WER.

$$C_WER \propto \sqrt[4]{(m-n)}$$

where: m is the number of employees in the company.

$$C_WER \approx WER$$

5

for: $m \gg n$

In a similar way that ESN information is used by the speech recognition system to dynamically load the active vocabulary set, the ESN information can also be used by the speech recognition system to select the appropriate acoustic model set. Speech recognition systems use previously collected speech samples to serve as reference templates against which new spoken speech samples are matched for classification. Statistical pattern recognition techniques are used to match new speech samples against reference templates to determine the closest match. These reference templates are referred to as acoustic models in the speech recognition system. Acoustic models may vary according to the regional accent and subsequently according to ESN locations. The speech recognition system can use site-specific acoustic models that are dynamically loaded based on the ESN information presented at the time of the call. Having site-specific acoustic models will also decrease the WER of the system.

The following specification illustrates an example of the NORTEL Speech Directory Calling Service. The state diagram shown in FIGURES 3 and 4 describes the user interface that users of the service experience and is not meant as an implementation specification. Some parts of the system, such as error recovery and instructions have been omitted.

In the description that follows, the use of *italics* denotes system state and the use of a dollar sign symbol denotes a parameter.

Description of the States in Alphabetical Order:Cancel:

- 5 Play Who
go to *Listening Timeout*

Idle:

- 10 /* Go to *Idle* anytime a user hangs up */
On an incoming call
Get ESN information
Set \$Location based on ESN information
go to *Listening Timeout*

15

KeyWord Handler:

Case

- | | | |
|----|--------------------|------------------------------------|
| | Service Locations: | go to <i>Service Location</i> |
| | Receptionist: | go to <i>Transfer Receptionist</i> |
| 20 | Cancel: | go to <i>Cancel</i> |
- End Case

Known Loc:

- Set \$Location to \$RecognizedWord
25 Play \$Location
Play EmployeeName
go to *Listening Timeout*

30 *Listening Timeout:*

- Listen for \$Timeout
If the user speaks
go to *Speech*
Else
35 go to *Prompt*

13

Loc Handler:

If \$Location is known location

go to Known Loc

Else

5 go to Unknown Loc

Prompt:

Case (state before Listening Timeout)

10 Idle:

Play Who

go to Listening Timeout

The rest of the states:

15 When \$Timeout expires on the first two times

Play TimeoutHelp.\$Location

\$Timeout = 4 sec

go to Listening Timeout

When \$Timeout expires on the third time

20 Play Difficulties

go to Transfer Receptionist

End Case

Service Location:

25 Play ServiceAvailable

Play \$Location list

Play Who

go to Listening Timeout

30 Speech:

Load the active vocabulary set from \$Location

Get \$RecognizedWord from Speech Recognizer

35

Case (\$RecognizedWord)

Rejection: go to Rejection Handler
\$Name: go to Transfer Call
\$Location: go to Loc Handler
5 Key Word: go to KeyWord Handler
End Case

Transfer Call:

Database Lookup for Employee Phone Number
10 Transfer the call
go to Idle

Transfer Receptionist :

Play TransferReceptionist
15 Transfer the call to the receptionist
go to Idle

Unknown Loc:

Play NotServiced.\$Location
20 go to Listening Timeout

Index of the Prerecorded Prompts in Alphabetical Order :

Calling:

25 Calling \$Name?

Difficulties:

The system is having difficulties with your request.
Transferring to a receptionist.
30

EmployeeName:

Employee name?

NotServiced:

35 This service is not available in \$Location. Choose
another location or for a list of serviced ESN locations,
say "Service Locations".

ServiceAvailable:

This service is available for the following Nortel/BNR locations: \$Location list.

5

TransferReceptionist:

Transferring to a receptionist.

Who:

10 Who would you like to call?

A specific embodiment of the invention has been disclosed and illustrated. It will be apparent to one skilled in the art that various changes in methodology and/or approach can be made without departing from the spirit and scope of this invention as defined in the appended claims.

15

20

I CLAIM:

1. A telephone network including:
 - a plurality of telephone exchanges each for
5 serving a plurality of telephone instruments and each being
interconnected with at least one other of the telephone
exchanges, for providing telephone communications between
telephone users associated with the telephone instruments;
and
10 a simulated telephone operator apparatus for
receiving a voiced speech request from a user for connection
to another of the telephone users and translating said
request into a directory number for use by one of the
telephone exchanges in accordance with a speech recognition
15 algorithm and an active speech recognition vocabulary
selected in accordance with the origin of the request.
2. A simulated telephone operator server for a
telephone network comprising:
 - 20 means for storing voice utterances of a calling
party telephone user;
means responsive to location information in
association with the telephone user for selecting an active
speech recognition vocabulary;
25 speech detection means for processing the stored
voice utterances in accordance with a speech recognition
algorithm and said active speech recognition vocabulary;
directory lookup means for identifying a directory
listing of a called party corresponding to a result of said
30 processing by the speech detection means; and
means for transmitting the directory listing to a
telephone exchange serving said called party.
3. A simulated telephone operator server as defined
35 in claim 2, wherein the directory lookup means defaults to
identification by a telephone attendant directory listing in
the event of there being no called party directory listing

corresponding to the result of said processing by the speech detection means.

4. A telephone exchange comprising:
- 5 a plurality of ports for serving a plurality of telephone users' telephone instruments via telephone lines;
- a trunk facility for connection to another telephone exchange;
- a switching network for connecting and
- 10 disconnecting the telephone instruments;
- a controller means for causing a newly OFF HOOK telephone instrument to be coupled via the switching network with a solicitation signal, and subsequently for being responsive to a telephone number received in association
- 15 with the newly OFF HOOK telephone instrument for completing a telephone call via the switching network;
- an originating register means for storing voice band signals received from the newly OFF HOOK telephone instrument via the switching network;
- 20 means for detecting digits represented by frequency signals, within the stored voice band signals, in accordance with a standard for key pad dialed telephone numbers, and for transmitting detecting digits to the call controller;
- 25 a simulated telephone operator apparatus for receiving and translating voice band signals in accordance with a speech recognition algorithm and an active speech recognition vocabulary selected in accordance with the origin of the voice band signals into a directory number for
- 30 use by the controller means; and
- an interface facility for transmitting the stored voice band signals via the switching network to the simulated telephone operator server apparatus in an event wherein the voice band signals did not include a key pad
- 35 dialed digit.

5. A telephone exchange as defined in claim 4, wherein the call controller means is operative to cause the interface means to transmit said stored voice band signals via the switching network to the simulated telephone operator server apparatus in an event wherein the voice band signals included a key pad dialed digit designating the simulated telephone operator apparatus.

6. A simulated telephone operator apparatus for receiving a user voiced speech request for connection to another user of a telephone network and translating said request into a directory number for use by an automatic telephone exchange, in accordance with a speech recognition algorithm and an active speech recognition vocabulary selected in accordance with the origin of the request.

7. A method for detecting a calling telephone user voiced speech request for connection to another telephone user via an automatic telephone exchange comprising:

20 storing a plurality of speech recognition vocabularies in association with geographic locations of users;

receiving the voiced speech request and information as to the geographic location of the user having

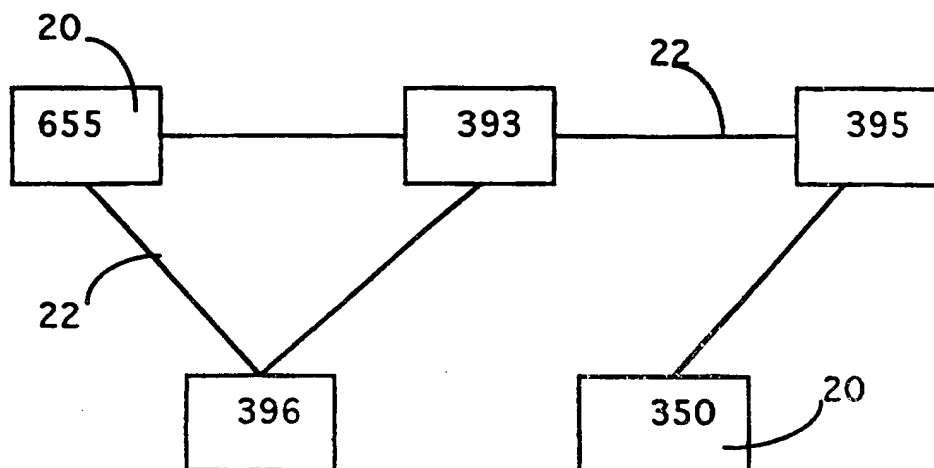
25 voiced the speech request from the automatic telephone exchange;

selecting an active speech recognition vocabulary in accordance with the information as to the geographic location of the user; and

30 in accordance with a speech recognition algorithm and the selected active speech recognition vocabulary, translating the received request into a directory number for use by the automatic telephone exchange in setting up a telephone connection between the calling telephone user and

35 said another telephone user.

1/2



-FIGURE 1

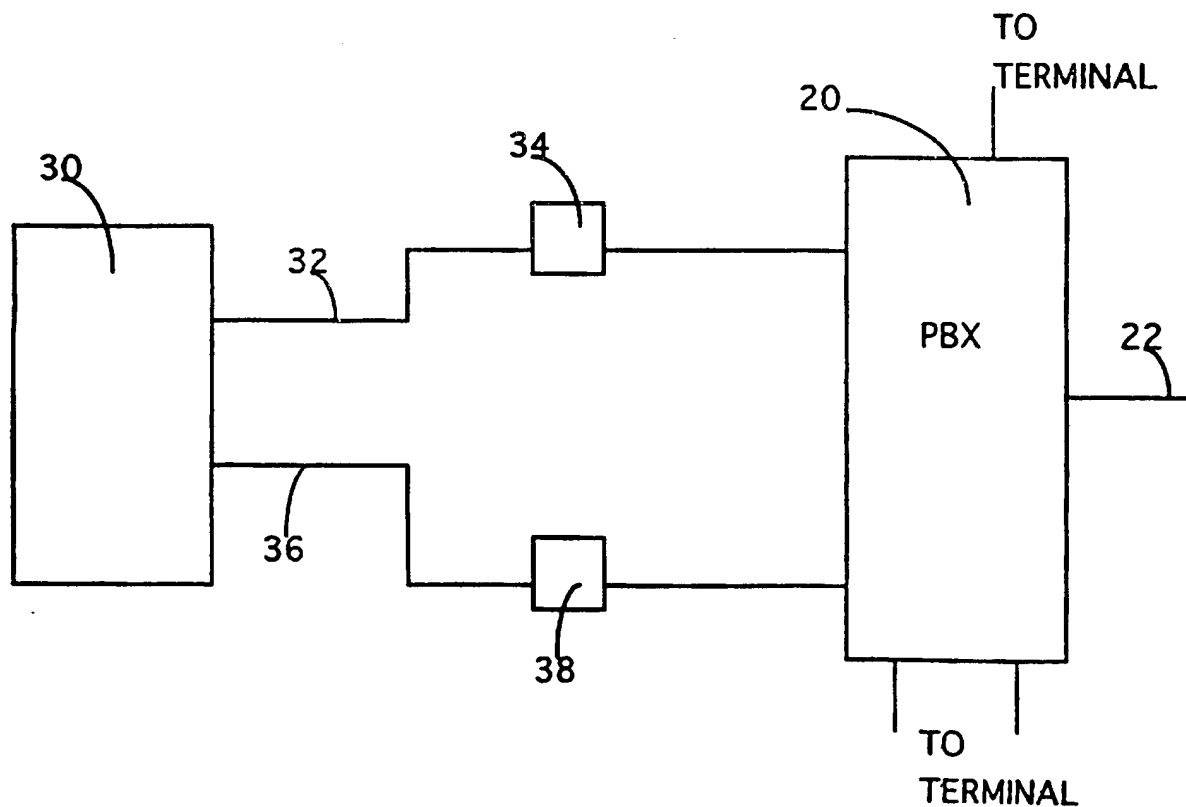


FIGURE 2

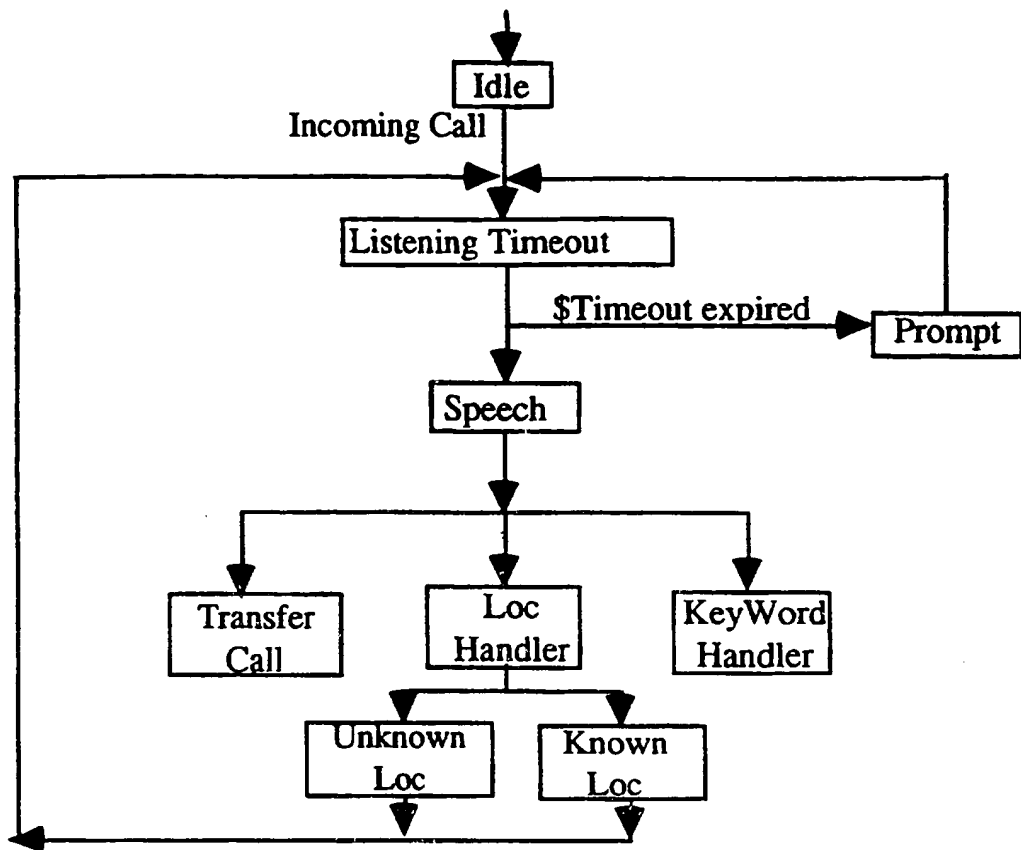


FIGURE 3

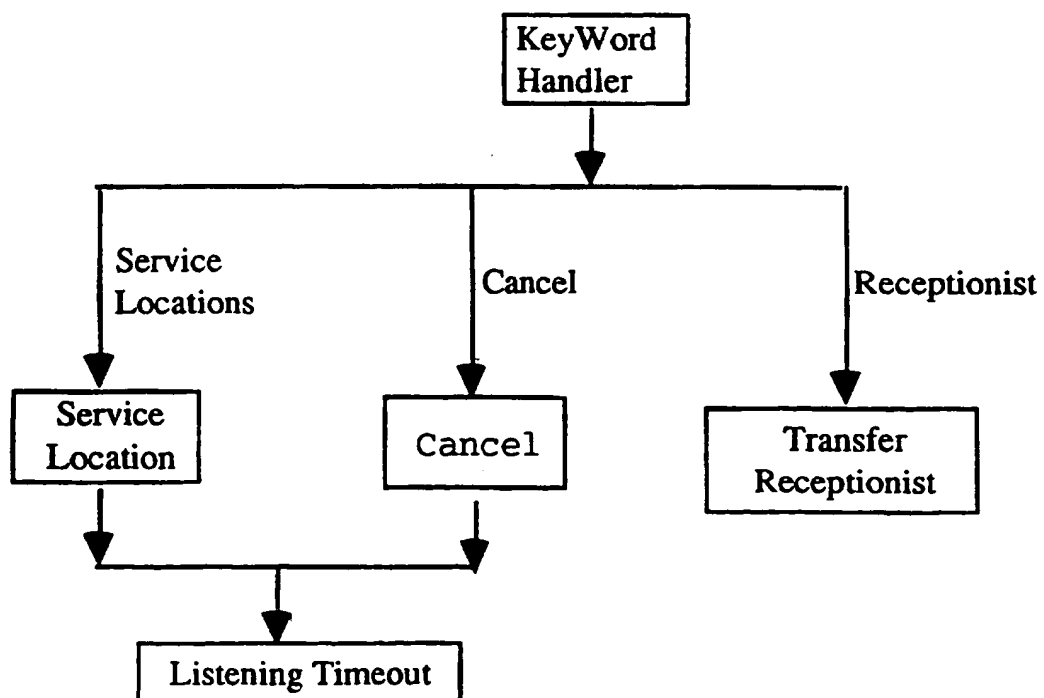


FIGURE 4

INTERNATIONAL SEARCH REPORT

International Application No.
PCT/CA 97/00008

A. CLASSIFICATION OF SUBJECT MATTER

H 04 M 1/27, G 10 L 5/06

According to International Patent Classification (IPC) or to both national classification and IPC⁶

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

H 04 M, G 10 L, H 04 Q

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP, A, 0 105 441 (SIEMENS) 18 April 1984 (18.04.84), page 1, line 1 - page 3, line 32; claim 1. --	1, 2, 4, 6, 7
A	US, A, 5 165 095 (BORCHERDING) 17 November 1992 (11.11.92), abstract; column 1, line 6 - column 2, line 37; column 3, line 22 - column 6, line 27; fig. 1, 2 (cited in the application). --	1, 2, 4, 6, 7
A	EP, A, 0 568 979 (SONY CORPORATION) 10 November 1993 (10.11.93), abstract; column 1, lines	1, 2, 4, 6, 7

☒ Further documents are listed in the continuation of box C.

☐ Patent family members are listed in annex.

* Special categories of cited documents :

- *A* document defining the general state of the art which is not considered to be of particular relevance
- *E* earlier document but published on or after the international filing date
- *L* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- *O* document referring to an oral disclosure, use, exhibition or other means
- *P* document published prior to the international filing date but later than the priority date claimed

- *T* later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- *X* document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- *Y* document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
- *&* document member of the same patent family

Date of the actual completion of the international search
21 March 1997

Date of mailing of the international search report

18.04.97

Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+ 31-70) 340-2040, Tlx. 31 651 epo nl,
Fax: (+ 31-70) 340-3016

Authorized officer

HAJOS e.h.

INTERNATIONAL SEARCH REPORT

-2-

International Application No
PCT/CA 97/00008

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
	43-50. --	
A	US, A, 5 390 278 (GUPTA et al.) 14 February 1995 (14.02.95), abstract (cited in the application). --	1,2,4, 6,7
A	EP, A, 0 045 941 (SIEMENS) 17 February 1982 (17.02.82), page 1, line 7 - page 4, line 9; fig.. --	1,2,4, 6,7
A	US, A, 5 091 947 (ARIYOSHI et al.) 25 February 1992 (25.02.92), abstract; column 1, line 10 - column 3, line 17 (cited in the application). ----	1,2,4, 6,7

ANHANG

zum internationalen Recherchen-
bericht über die internationale
Patentanmeldung Nr.

ANNEX

to the International Search
Report to the International Patent
Application No.

ANNEXE

au rapport de recherche inter-
national relatif à la demande de brevet
international n°

PCT/CA 97/00008 SAE 148639

In diesem Anhang sind die Mitglieder
der Patentfamilien der im obenge-
nannten internationalen Recherchenbericht
angeführten Patentdokumente angegeben.
Diese Angaben dienen nur zur Unter-
richtung und erfolgen ohne Gewähr.

This Annex lists the patent family
members relating to the patent documents
cited in the above-mentioned inter-
national search report. The Office is
in no way liable for these particulars
which are given merely for the purpose
of information.

La présente annexe indique les
membres de la famille de brevets
relatifs aux documents de brevets cités
dans le rapport de recherche inter-
national visée ci-dessus. Les renseigne-
ments fournis sont donnés à titre indica-
tif et n'engagent pas la responsabilité
de l'Office.

Im Recherchenbericht angeführtes Patentdokument Patent document cited in search report Document de brevet cité dans le rapport de recherche	Datum der Veröffentlichung Publication date Date de publication	Mitglied(er) der Patentfamilie Patent family member(s) Membre(s) de la famille de brevets	Datum der Veröffentlichung Publication date Date de publication
EP A1 105441	18-04-84	EP A1 105441 EP A2 105441 EP A3 105441 EP A4 105441 EP A5 105441 EP A6 105441 EP A7 105441 EP A8 105441 EP A9 105441 EP A10 105441 EP A11 105441 EP A12 105441 EP A13 105441 EP A14 105441 EP A15 105441 EP A16 105441 EP A17 105441 EP A18 105441 EP A19 105441 EP A20 105441 EP A21 105441 EP A22 105441 EP A23 105441 EP A24 105441 EP A25 105441 EP A26 105441 EP A27 105441 EP A28 105441 EP A29 105441 EP A30 105441 EP A31 105441 EP A32 105441 EP A33 105441 EP A34 105441 EP A35 105441 EP A36 105441 EP A37 105441 EP A38 105441 EP A39 105441 EP A40 105441 EP A41 105441 EP A42 105441 EP A43 105441 EP A44 105441 EP A45 105441 EP A46 105441 EP A47 105441 EP A48 105441 EP A49 105441 EP A50 105441 EP A51 105441 EP A52 105441 EP A53 105441 EP A54 105441 EP A55 105441 EP A56 105441 EP A57 105441 EP A58 105441 EP A59 105441 EP A60 105441 EP A61 105441 EP A62 105441 EP A63 105441 EP A64 105441 EP A65 105441 EP A66 105441 EP A67 105441 EP A68 105441 EP A69 105441 EP A70 105441 EP A71 105441 EP A72 105441 EP A73 105441 EP A74 105441 EP A75 105441 EP A76 105441 EP A77 105441 EP A78 105441 EP A79 105441 EP A80 105441 EP A81 105441 EP A82 105441 EP A83 105441 EP A84 105441 EP A85 105441 EP A86 105441 EP A87 105441 EP A88 105441 EP A89 105441 EP A90 105441 EP A91 105441 EP A92 105441 EP A93 105441 EP A94 105441 EP A95 105441 EP A96 105441 EP A97 105441 EP A98 105441 EP A99 105441 EP A100 105441 EP A101 105441 EP A102 105441 EP A103 105441 EP A104 105441 EP A105 105441 EP A106 105441 EP A107 105441 EP A108 105441 EP A109 105441 EP A110 105441 EP A111 105441 EP A112 105441 EP A113 105441 EP A114 105441 EP A115 105441 EP A116 105441 EP A117 105441 EP A118 105441 EP A119 105441 EP A120 105441 EP A121 105441 EP A122 105441 EP A123 105441 EP A124 105441 EP A125 105441 EP A126 105441 EP A127 105441 EP A128 105441 EP A129 105441 EP A130 105441 EP A131 105441 EP A132 105441 EP A133 105441 EP A134 105441 EP A135 105441 EP A136 105441 EP A137 105441 EP A138 105441 EP A139 105441 EP A140 105441 EP A141 105441 EP A142 105441 EP A143 105441 EP A144 105441 EP A145 105441 EP A146 105441 EP A147 105441 EP A148 105441 EP A149 105441 EP A150 105441 EP A151 105441 EP A152 105441 EP A153 105441 EP A154 105441 EP A155 105441 EP A156 105441 EP A157 105441 EP A158 105441 EP A159 105441 EP A160 105441 EP A161 105441 EP A162 105441 EP A163 105441 EP A164 105441 EP A165 105441 EP A166 105441 EP A167 105441 EP A168 105441 EP A169 105441 EP A170 105441 EP A171 105441 EP A172 105441 EP A173 105441 EP A174 105441 EP A175 105441 EP A176 105441 EP A177 105441 EP A178 105441 EP A179 105441 EP A180 105441 EP A181 105441 EP A182 105441 EP A183 105441 EP A184 105441 EP A185 105441 EP A186 105441 EP A187 105441 EP A188 105441 EP A189 105441 EP A190 105441 EP A191 105441 EP A192 105441 EP A193 105441 EP A194 105441 EP A195 105441 EP A196 105441 EP A197 105441 EP A198 105441 EP A199 105441 EP A200 105441 EP A201 105441 EP A202 105441 EP A203 105441 EP A204 105441 EP A205 105441 EP A206 105441 EP A207 105441 EP A208 105441 EP A209 105441 EP A210 105441 EP A211 105441 EP A212 105441 EP A213 105441 EP A214 105441 EP A215 105441 EP A216 105441 EP A217 105441 EP A218 105441 EP A219 105441 EP A220 105441 EP A221 105441 EP A222 105441 EP A223 105441 EP A224 105441 EP A225 105441 EP A226 105441 EP A227 105441 EP A228 105441 EP A229 105441 EP A230 105441 EP A231 105441 EP A232 105441 EP A233 105441 EP A234 105441 EP A235 105441 EP A236 105441 EP A237 105441 EP A238 105441 EP A239 105441 EP A240 105441 EP A241 105441 EP A242 105441 EP A243 105441 EP A244 105441 EP A245 105441 EP A246 105441 EP A247 105441 EP A248 105441 EP A249 105441 EP A250 105441 EP A251 105441 EP A252 105441 EP A253 105441 EP A254 105441 EP A255 105441 EP A256 105441 EP A257 105441 EP A258 105441 EP A259 105441 EP A260 105441 EP A261 105441 EP A262 105441 EP A263 105441 EP A264 105441 EP A265 105441 EP A266 105441 EP A267 105441 EP A268 105441 EP A269 105441 EP A270 105441 EP A271 105441 EP A272 105441 EP A273 105441 EP A274 105441 EP A275 105441 EP A276 105441 EP A277 105441 EP A278 105441 EP A279 105441 EP A280 105441 EP A281 105441 EP A282 105441 EP A283 105441 EP A284 105441 EP A285 105441 EP A286 105441 EP A287 105441 EP A288 105441 EP A289 105441 EP A290 105441 EP A291 105441 EP A292 105441 EP A293 105441 EP A294 105441 EP A295 105441 EP A296 105441 EP A297 105441 EP A298 105441 EP A299 105441 EP A300 105441 EP A301 105441 EP A302 105441 EP A303 105441 EP A304 105441 EP A305 105441 EP A306 105441 EP A307 105441 EP A308 105441 EP A309 105441 EP A310 105441 EP A311 105441 EP A312 105441 EP A313 105441 EP A314 105441 EP A315 105441 EP A316 105441 EP A317 105441 EP A318 105441 EP A319 105441 EP A320 105441 EP A321 105441 EP A322 105441 EP A323 105441 EP A324 105441 EP A325 105441 EP A326 105441 EP A327 105441 EP A328 105441 EP A329 105441 EP A330 105441 EP A331 105441 EP A332 105441 EP A333 105441 EP A334 105441 EP A335 105441 EP A336 105441 EP A337 105441 EP A338 105441 EP A339 105441 EP A340 105441 EP A341 105441 EP A342 105441 EP A343 105441 EP A344 105441 EP A345 105441 EP A346 105441 EP A347 105441 EP A348 105441 EP A349 105441 EP A350 105441 EP A351 105441 EP A352 105441 EP A353 105441 EP A354 105441 EP A355 105441 EP A356 105441 EP A357 105441 EP A358 105441 EP A359 105441 EP A360 105441 EP A361 105441 EP A362 105441 EP A363 105441 EP A364 105441 EP A365 105441 EP A366 105441 EP A367 105441 EP A368 105441 EP A369 105441 EP A370 105441 EP A371 105441 EP A372 105441 EP A373 105441 EP A374 105441 EP A375 105441 EP A376 105441 EP A377 105441 EP A378 105441 EP A379 105441 EP A380 105441 EP A381 105441 EP A382 105441 EP A383 105441 EP A384 105441 EP A385 105441 EP A386 105441 EP A387 105441 EP A388 105441 EP A389 105441 EP A390 105441 EP A391 105441 EP A392 105441 EP A393 105441 EP A394 105441 EP A395 105441 EP A396 105441 EP A397 105441 EP A398 105441 EP A399 105441 EP A400 105441 EP A401 105441 EP A402 105441 EP A403 105441 EP A404 105441 EP A405 105441 EP A406 105441 EP A407 105441 EP A408 105441 EP A409 105441 EP A410 105441 EP A411 105441 EP A412 105441 EP A413 105441 EP A414 105441 EP A415 105441 EP A416 105441 EP A417 105441 EP A418 105441 EP A419 105441 EP A420 105441 EP A421 105441 EP A422 105441 EP A423 105441 EP A424 105441 EP A425 105441 EP A426 105441 EP A427 105441 EP A428 105441 EP A429 105441 EP A430 105441 EP A431 105441 EP A432 105441 EP A433 105441 EP A434 105441 EP A435 105441 EP A436 105441 EP A437 105441 EP A438 105441 EP A439 105441 EP A440 105441 EP A441 105441 EP A442 105441 EP A443 105441 EP A444 105441 EP A445 105441 EP A446 105441 EP A447 105441 EP A448 105441 EP A449 105441 EP A450 105441 EP A451 105441 EP A452 105441 EP A453 105441 EP A454 105441 EP A455 105441 EP A456 105441 EP A457 105441 EP A458 105441 EP A459 105441 EP A460 105441 EP A461 105441 EP A462 105441 EP A463 105441 EP A464 105441 EP A465 105441 EP A466 105441 EP A467 105441 EP A468 105441 EP A469 105441 EP A470 105441 EP A471 105441 EP A472 105441 EP A473 105441 EP A474 105441 EP A475 105441 EP A476 105441 EP A477 105441 EP A478 105441 EP A479 105441 EP A480 105441 EP A481 105441 EP A482 105441 EP A483 105441 EP A484 105441 EP A485 105441 EP A486 105441 EP A487 105441 EP A488 105441 EP A489 105441 EP A490 105441 EP A491 105441 EP A492 105441 EP A493 105441 EP A494 105441 EP A495 105441 EP A496 105441 EP A497 105441 EP A498 105441 EP A499 105441 EP A500 105441 EP A501 105441 EP A502 105441 EP A503 105441 EP A504 105441 EP A505 105441 EP A506 105441 EP A507 105441 EP A508 105441 EP A509 105441 EP A510 105441 EP A511 105441 EP A512 105441 EP A513 105441 EP A514 105441 EP A515 105441 EP A516 105441 EP A517 105441 EP A518 105441 EP A519 105441 EP A520 105441 EP A521 105441 EP A522 105441 EP A523 105441 EP A524 105441 EP A525 105441 EP A526 105441 EP A527 105441 EP A528 105441 EP A529 105441 EP A530 105441 EP A531 105441 EP A532 105441 EP A533 105441 EP A534 105441 EP A535 105441 EP A536 105441 EP A537 105441 EP A538 105441 EP A539 105441 EP A540 105441 EP A541 105441 EP A542 105441 EP A543 105441 EP A544 105441 EP A545 105441 EP A546 105441 EP A547 105441 EP A548 105441 EP A549 105441 EP A550 105441 EP A551 105441 EP A552 105441 EP A553 105441 EP A554 105441 EP A555 105441 EP A556 105441 EP A557 105441 EP A558 105441 EP A559 105441 EP A560 105441 EP A561 105441 EP A562 105441 EP A563 105441 EP A564 105441 EP A565 105441 EP A566 105441 EP A567 105441 EP A568 105441 EP A569 105441 EP A570 105441 EP A571 105441 EP A572 105441 EP A573 105441 EP A574 105441 EP A575 105441 EP A576 105441 EP A577 105441 EP A578 105441 EP A579 105441 EP A580 105441 EP A581 105441 EP A582 105441 EP A583 105441 EP A584 105441 EP A585 105441 EP A586 105441 EP A587 105441 EP A588 105441 EP A589 105441 EP A590 105441 EP A591 105441 EP A592 105441 EP A593 105441 EP A594 105441 EP A595 105441 EP A596 105441 EP A597 105441 EP A598 105441 EP A599 105441 EP A600 105441 EP A601 105441 EP A602 105441 EP A603 105441 EP A604 105441 EP A605 105441 EP A606 105441 EP A607 105441 EP A608 105441 EP A609 105441 EP A610 105441 EP A611 105441 EP A612 105441 EP A613 105441 EP A614 105441 EP A615 105441 EP A616 105441 EP A617 105441 EP A618 105441 EP A619 105441 EP A620 105441 EP A621 105441 EP A622 105441 EP A623 105441 EP A624 105441 EP A625 105441 EP A626 105441 EP A627 105441 EP A628 105441 EP A629 105441 EP A630 105441 EP A631 105441 EP A632 105441 EP A633 105441 EP A634 105441 EP A635 105441 EP A636 105441 EP A637 105441 EP A638 105441 EP A639 105441 EP A640 105441 EP A641 105441 EP A642 105441 EP A643 105441 EP A644 105441 EP A645 105441 EP A646 105441 EP A647 105441 EP A648 105441 EP A649 105441 EP A650 105441 EP A651 105441 EP A652 105441 EP A653 105441 EP A654 105441 EP A655 105441 EP A656 105441 EP A657 105441 EP A658 105441 EP A659 105441 EP A660 105441 EP A661 105441 EP A662 105441 EP A663 105441 EP A664 105441 EP A665 105441 EP A666 105441 EP A667 105441 EP A668 105441 EP A669 105441 EP A670 105441 EP A671 105441 EP A672 105441 EP A673 105441 EP A674 105441 EP A675 105441 EP A676 105441 EP A677 105441 EP A678 105441 EP A679 105441 EP A680 105441 EP A681 105441 EP A682 105441 EP A683 105441 EP A684 105441 EP A685 105441 EP A686 105441 EP A687 105441 EP A688 105441 EP A689 105441 EP A690 105441 EP A691 105441 EP A692 105441 EP A693 105441 EP A694 105441 EP A695 105441 EP A696 105441 EP A697 105441 EP A698 105441 EP A699 105441 EP A700 105441 EP A701 105441 EP A702 105441 EP A703 105441 EP A704 105441 EP A705 105441 EP A706 105441 EP A707 105441 EP A708 105441 EP A709 105441 EP A710 105441 EP A711 105441 EP A712 105441 EP A713 105441 EP A714 105441 EP A715 105441 EP A716 105441 EP A717 105441 EP A718 105441 EP A719 105441 EP A720 105441 EP A721 105441 EP A722 105441 EP A723 105441 EP A724 105441 EP A725 105441 EP A726 105441 EP A727 105441 EP A728 105441 EP A729 105441 EP A730 105441 EP A731 105441 EP A732 105441 EP A733 105441 EP A734 105441 EP A735 105441 EP A736 105441 EP A737 105441 EP A738 105441 EP A739 105441 EP A740 105441 EP A741 105441 EP A742 105441 EP A743 105441 EP A744 105441 EP A745 105441 EP A746 105441 EP A747 105441 EP A748 105441 EP A749 105441 EP A750 105441 EP A751 105441 EP A752 105441 EP A753 105441 EP A754 105441 EP A755 105441 EP A756 105441 EP A757 105441 EP A758 105441 EP A759 105441 EP A760 105441 EP A761 105441 EP A762 105441 EP A763 105441 EP A764 105441 EP A765 105441 EP A766 105441 EP A767 105441 EP A768 105441 EP A769 105441 EP A770 105441 EP A771 105441 EP A772 105441 EP A773 105441 EP A774 105441 EP A775 105441 EP A776 105441 EP A777 105441 EP A778 105441 EP A779 105441 EP A780 105441 EP A781 105441 EP A782 105441 EP A783 105441 EP A784 105441 EP A785 105441 EP A786 105441 EP A787 105441 EP A788 105441 EP A789 105441 EP A790 105441 EP A791 105441 EP A792 105441 EP A793 105441 EP A794 105441 EP A795 105441 EP A796 105441 EP A797 105441 EP A798 105441 EP A799 105441 EP A800 105441 EP A801 105441 EP A802 105441 EP A803 105441 EP A804 105441 EP A805 105441 EP A806 105441 EP A807 105441 EP A808 105441 EP A809 105441 EP A810 105441 EP A811 105441 EP A812 105441 EP A813 105441 EP A814 105441 EP A815 105441 EP A816 105441 EP A817 105441 EP A818 105441 EP A819 105441 EP A820 105441 EP A821 105441 EP A822 105441 EP A823 105441 EP A824 105441 EP A825 105441 EP A826 105441 EP A827 105441 EP A828 105441 EP A829 105441 EP A830 105441 EP A831 105441 EP A832 105441 EP A833 105441 EP A834 105441 EP A835 105441 EP A836 105441 EP A837 105441 EP A838 105441 EP A839 105441 EP A840 105441 EP A841 105441 EP A842 105441 EP A843 105441 EP A844 105441 EP A845 105441 EP A846 105441 EP A847 105441 EP A848 105441 EP A849 105441 EP A850 105441 EP A851 105441 EP A852 105441 EP A853 105	

